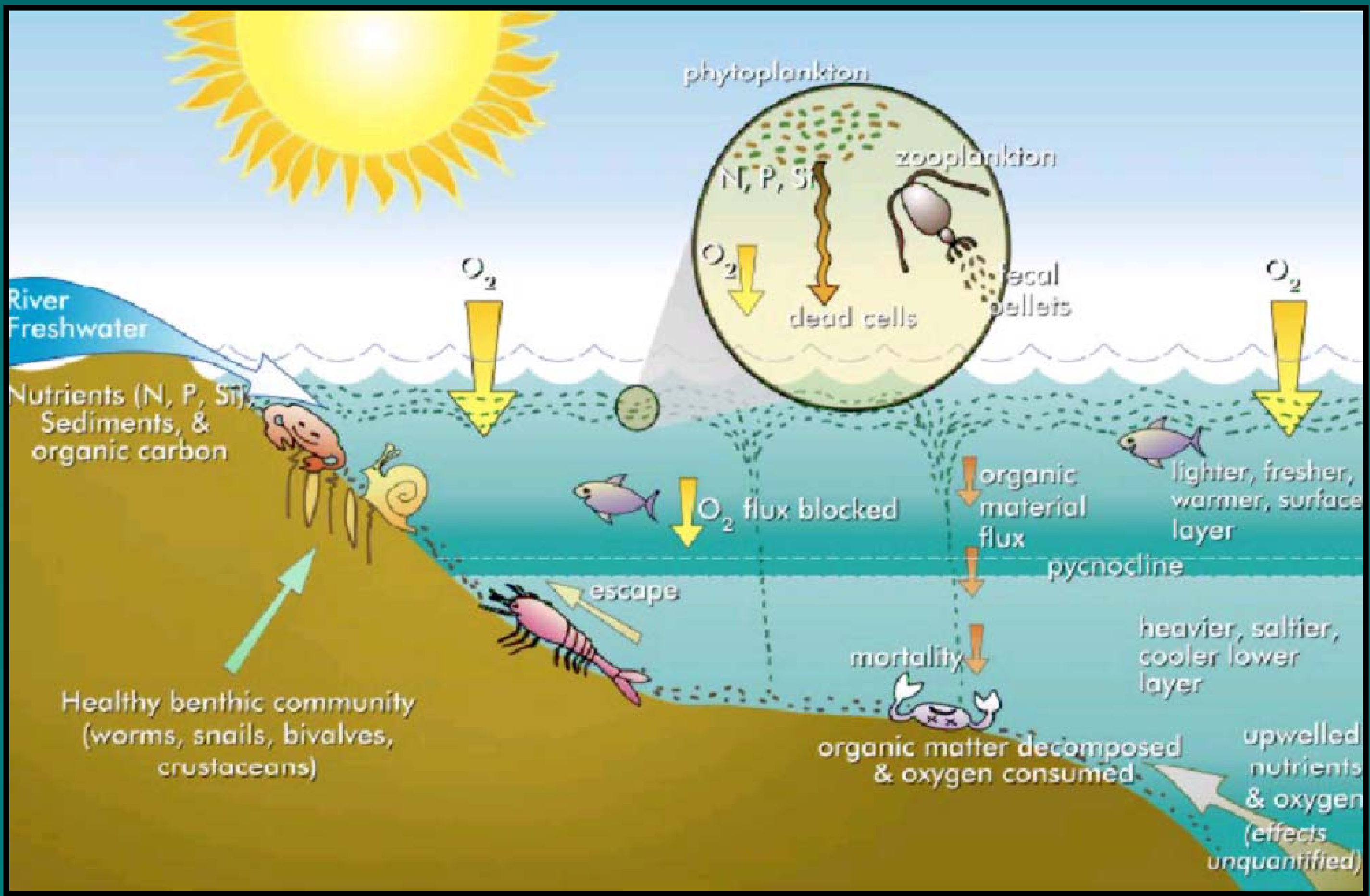
Gulf of Mexico Hypoxia and Mississippi River Basin Nutrient Losses

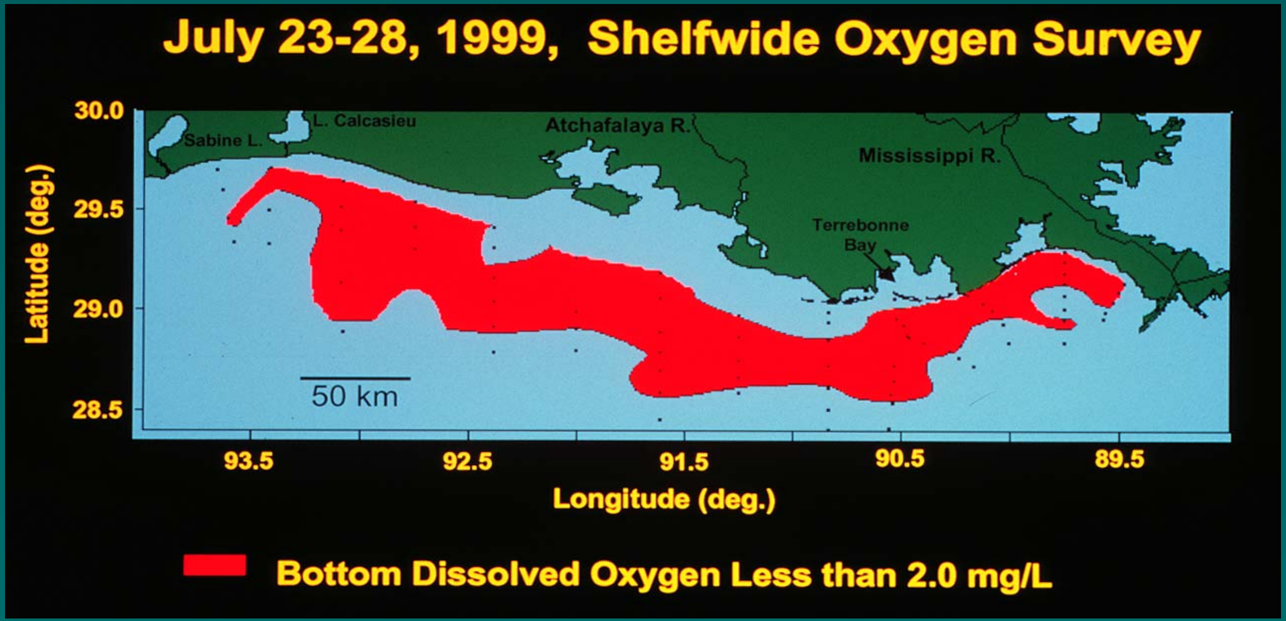
Herb Buxton,
Toxic Substances
Hydrology Program

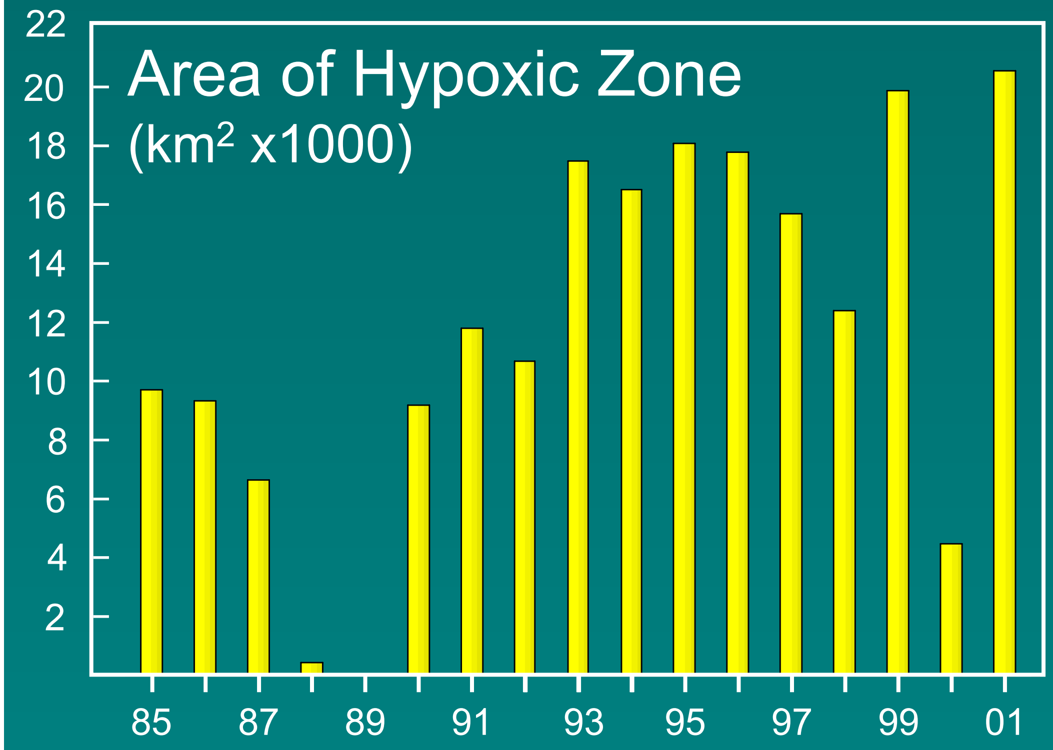
What Causes Gulf Hypoxia?

"Hypoxia in the Northern Gulf of Mexico is caused primarily by excess N delivered by the MARB in combination with stratification of Gulf Waters." – *Integrated Assessment, 2000*



Gulf Hypoxia





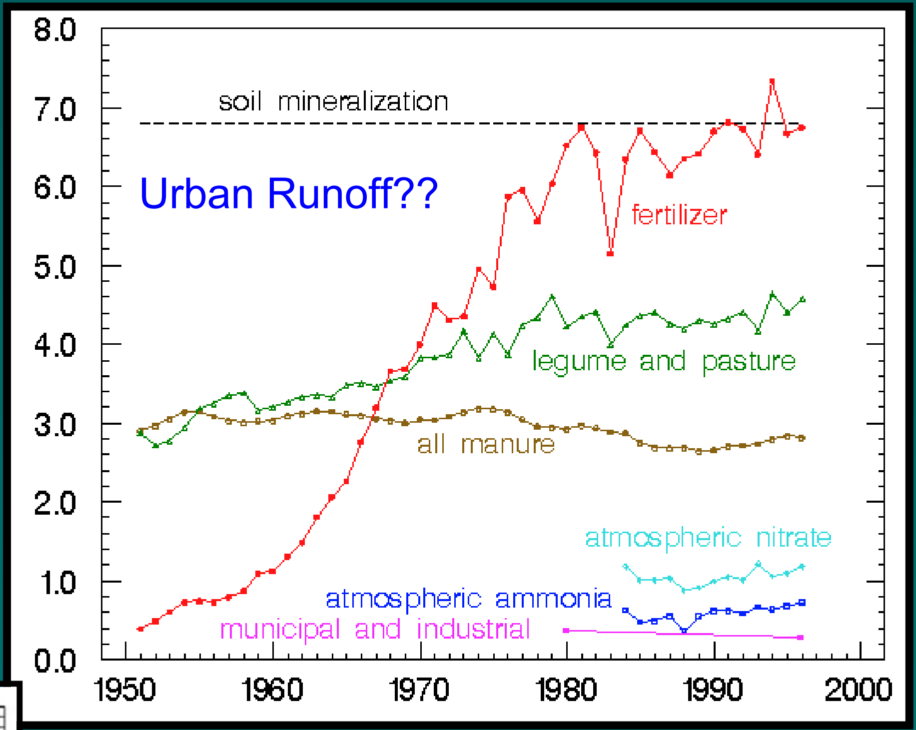
Hypoxic Zone

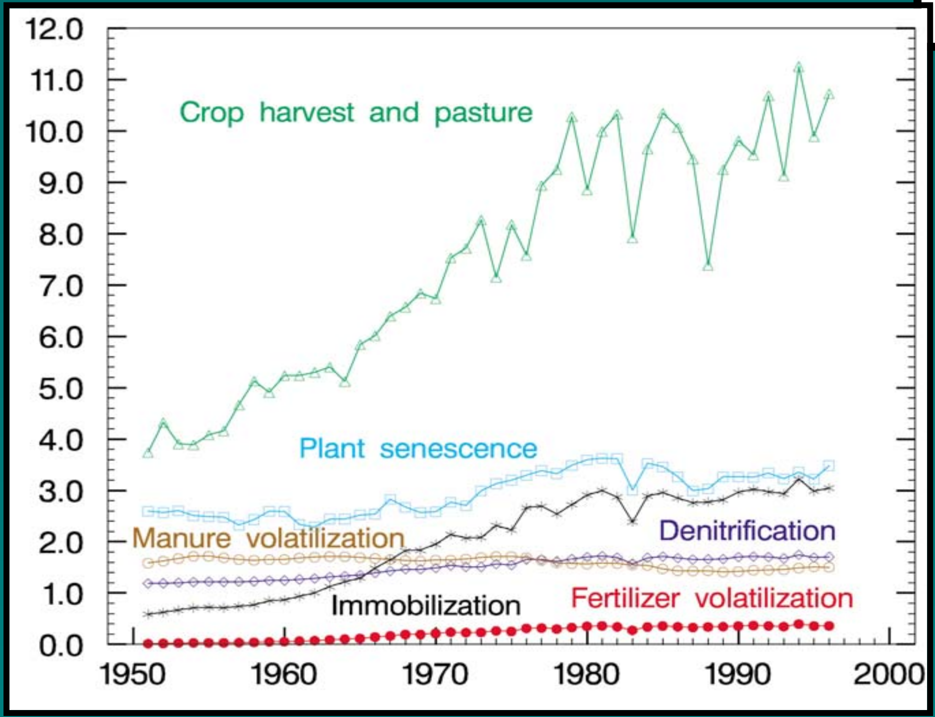
- Measured since 1985
- Largest extent, 2001

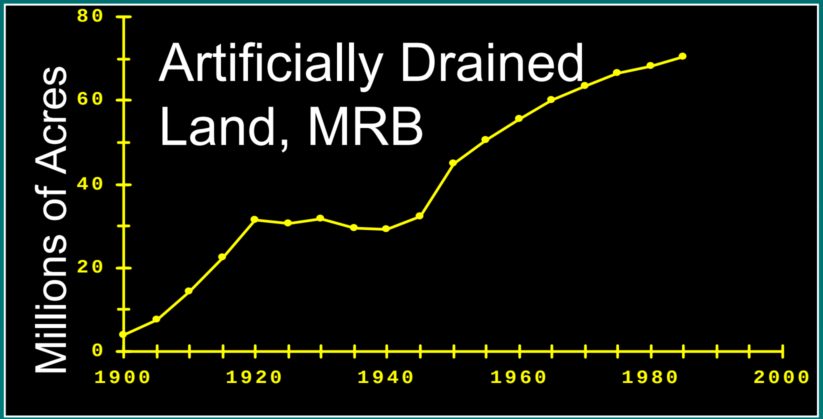
NOAA, Rabalais et al.

Nitrogen Cycling

- N Inputs and Outputs (Million metric Tons).
- Landscape changes.





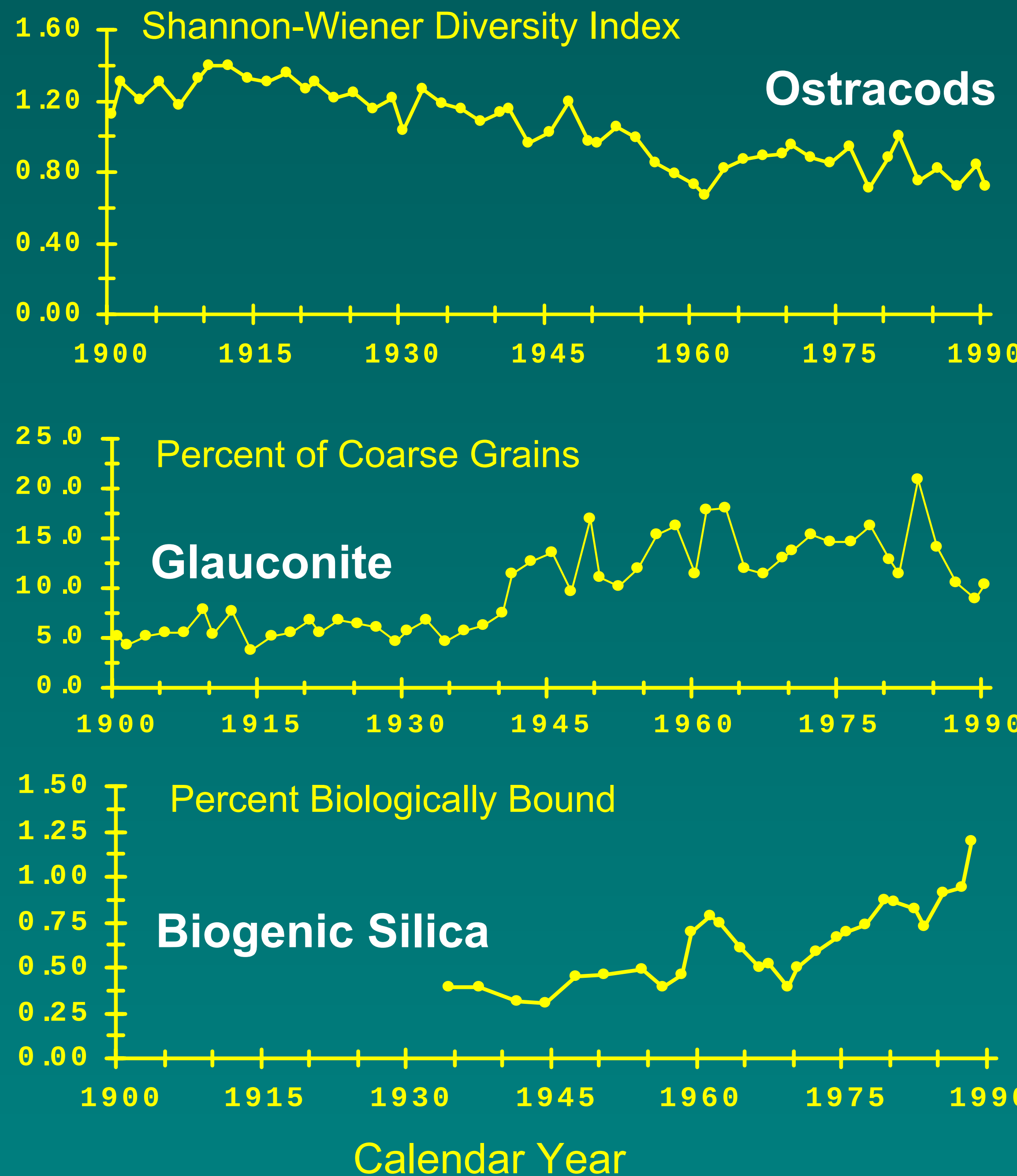


USGS

Long-term Biological Signals

Sediment cores suggest increased hypoxic stress:

- << Ostracod Diversity
- >> Glauconite,
- >> Biogenic Silica.

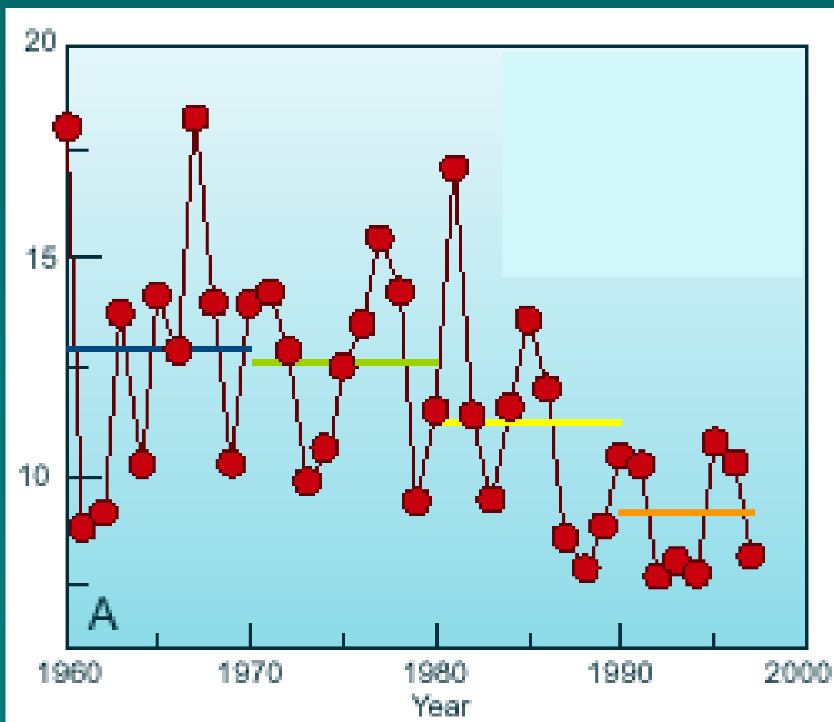


Rabalais, et al

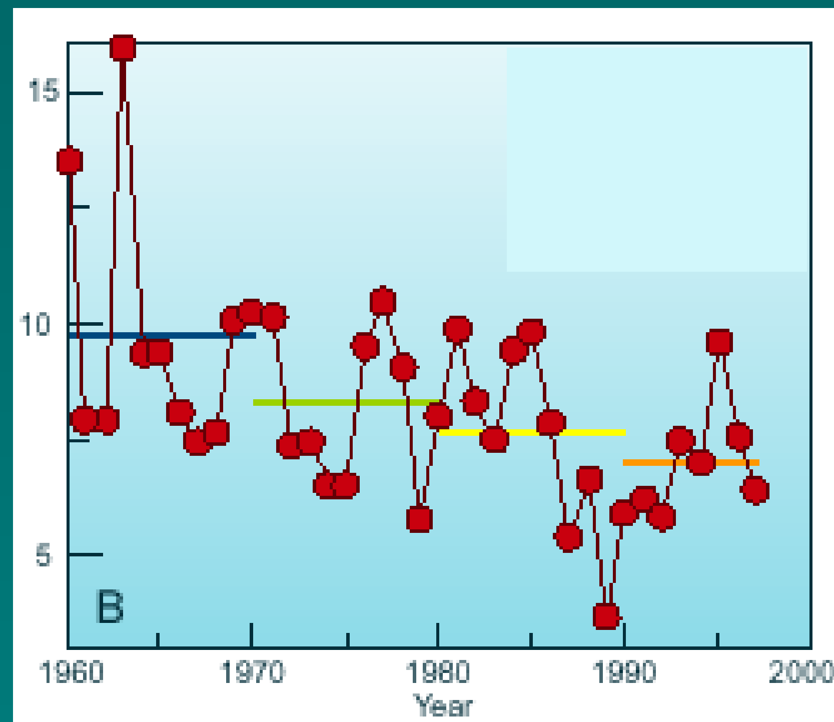
Potential Fisheries Impacts

Changes in Catch Per Unit Effort

Brown Shrimp

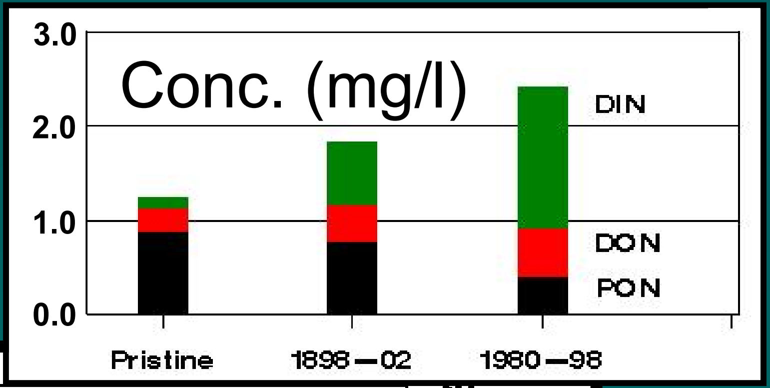


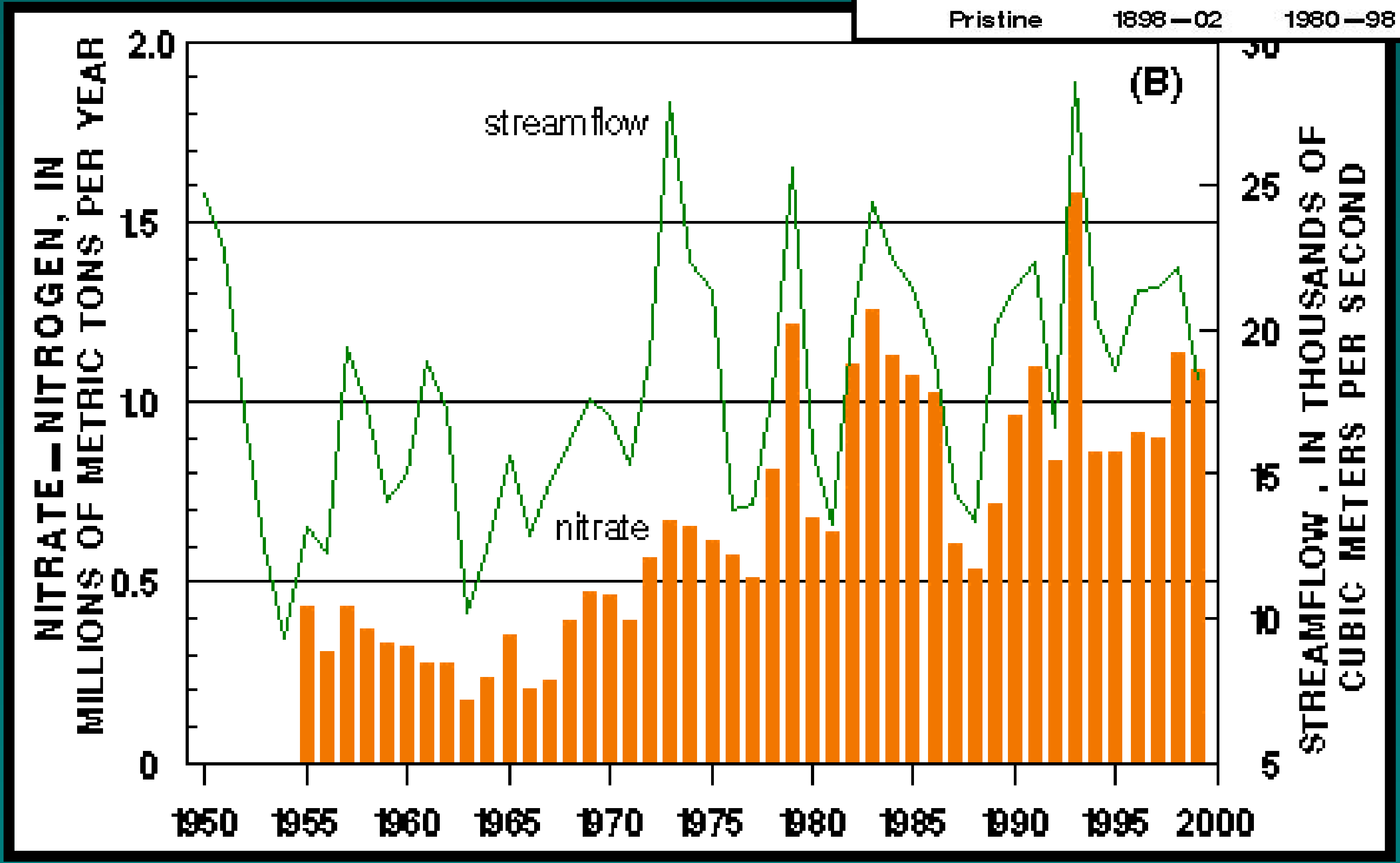
White Shrimp



Source: NOAA

NITRATE LOAD, ANNUAL STREAMFLOW AND N CONCENTRATION

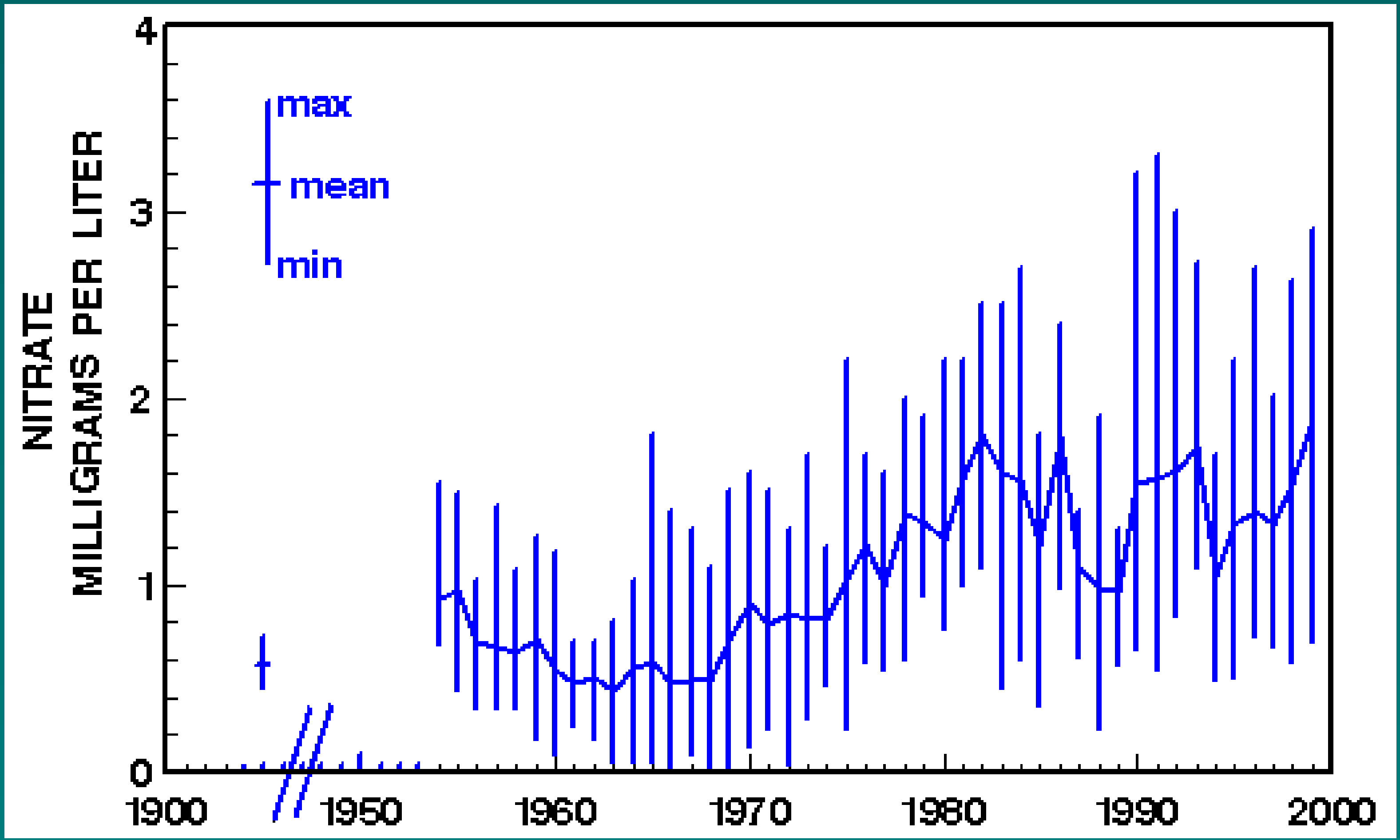




1955-70 Avg. = 350,000 t/yr 1980-99 Avg. = 950,000 t/y

USGS

Nitrate Concentration at the Mouth, MARB



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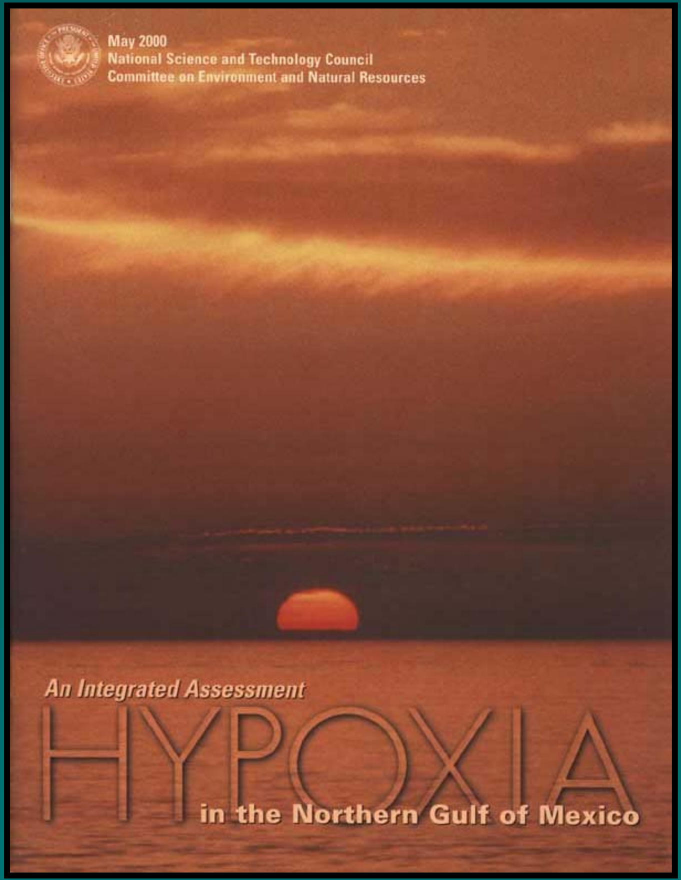
MR/GM Watershed Nutrients Task Force

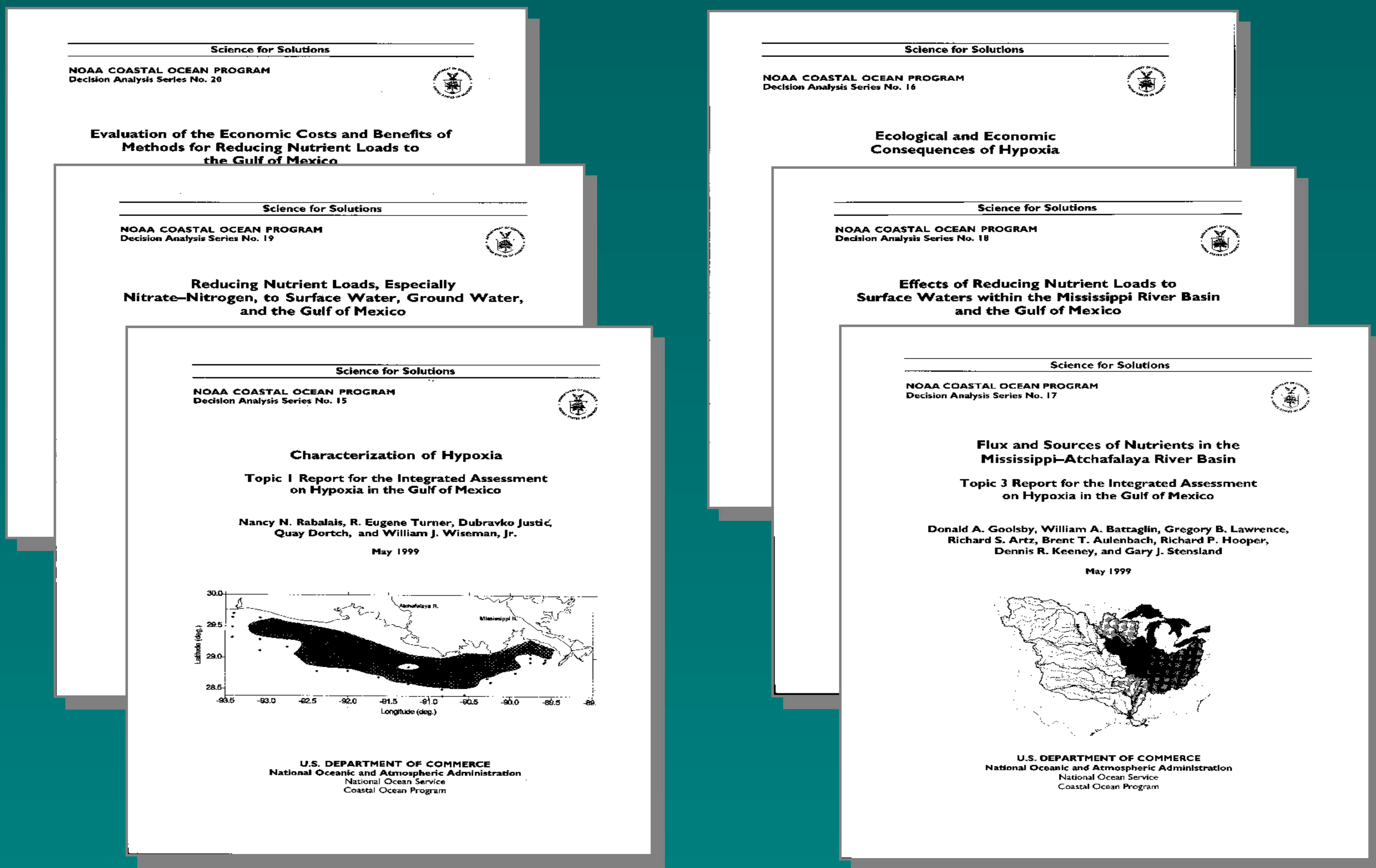
- Federal Agencies (USEPA*, NOAA, USDA, USACE, USFWS, USGS)
- States (Agriculture and Environment Departments)
- Tribal representatives



CENR Science Assessment, May 2000

USGS

Science Assessment Technical Reports



Science for Solutions

NOAA COASTAL OCEAN PROGRAM
Decision Analysis Series No. 20

Evaluation of the Economic Costs and Benefits of Methods for Reducing Nutrient Loads to the Gulf of Mexico

Science for Solutions

NOAA COASTAL OCEAN PROGRAM
Decision Analysis Series No. 19

Reducing Nutrient Loads, Especially Nitrate–Nitrogen, to Surface Water, Ground Water, and the Gulf of Mexico

Science for Solutions

NOAA COASTAL OCEAN PROGRAM
Decision Analysis Series No. 15

Characterization of Hypoxia

Topic 1 Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico

Nancy N. Rabalais, R. Eugene Turner, Dubravko Justić, Quay Dortch, and William J. Wiseman, Jr.

May 1999

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service
Coastal Ocean Program

Science for Solutions

NOAA COASTAL OCEAN PROGRAM
Decision Analysis Series No. 16

Ecological and Economic Consequences of Hypoxia

Science for Solutions

NOAA COASTAL OCEAN PROGRAM
Decision Analysis Series No. 18

Effects of Reducing Nutrient Loads to Surface Waters within the Mississippi River Basin and the Gulf of Mexico

Science for Solutions

NOAA COASTAL OCEAN PROGRAM
Decision Analysis Series No. 17

Flux and Sources of Nutrients in the Mississippi–Atchafalaya River Basin

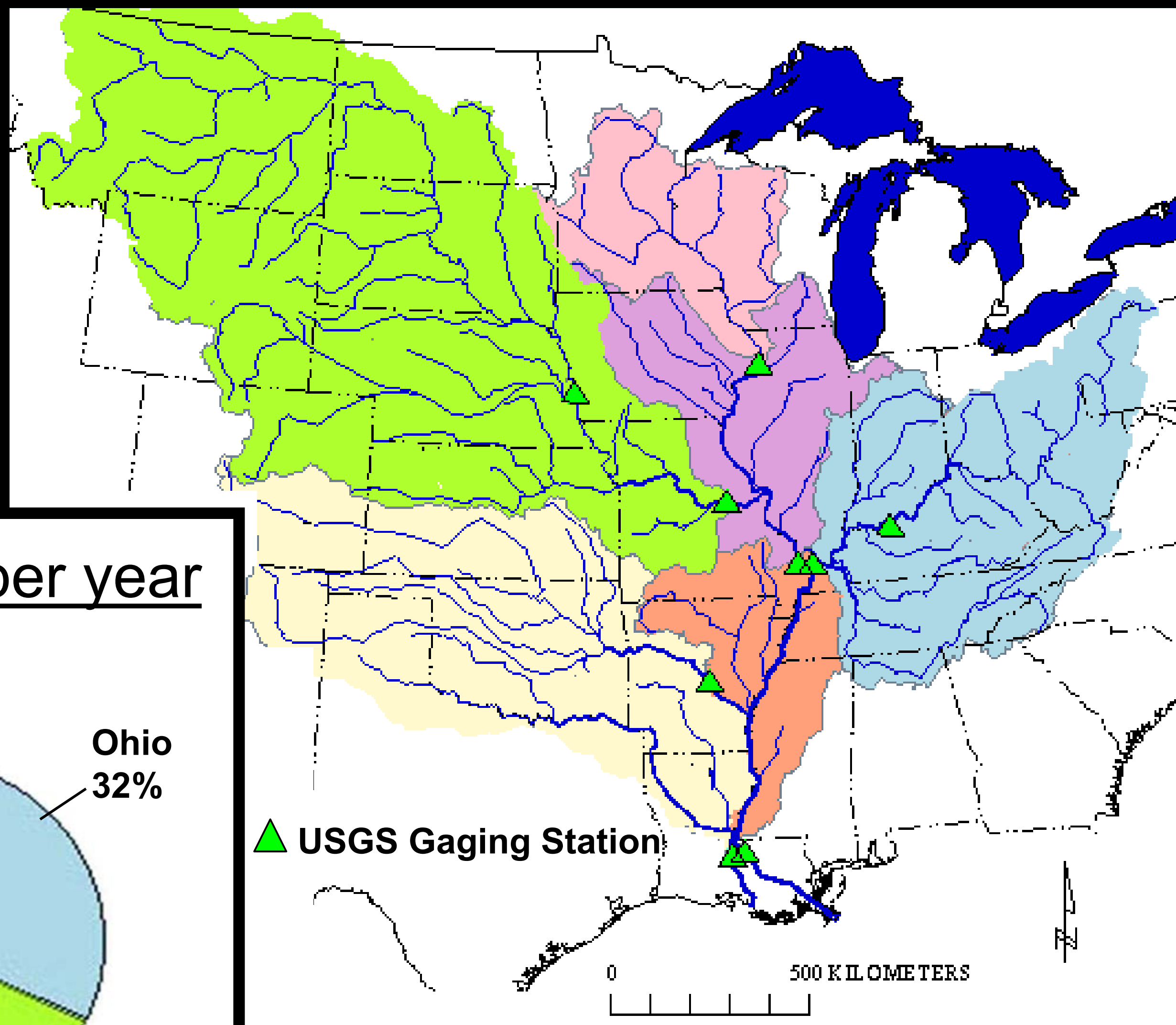
Topic 3 Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico

Donald A. Goolsby, William A. Battaglin, Gregory B. Lawrence, Richard S. Artz, Brent T. Aulenbach, Richard P. Hooper, Dennis R. Keeney, and Gary J. Stensland

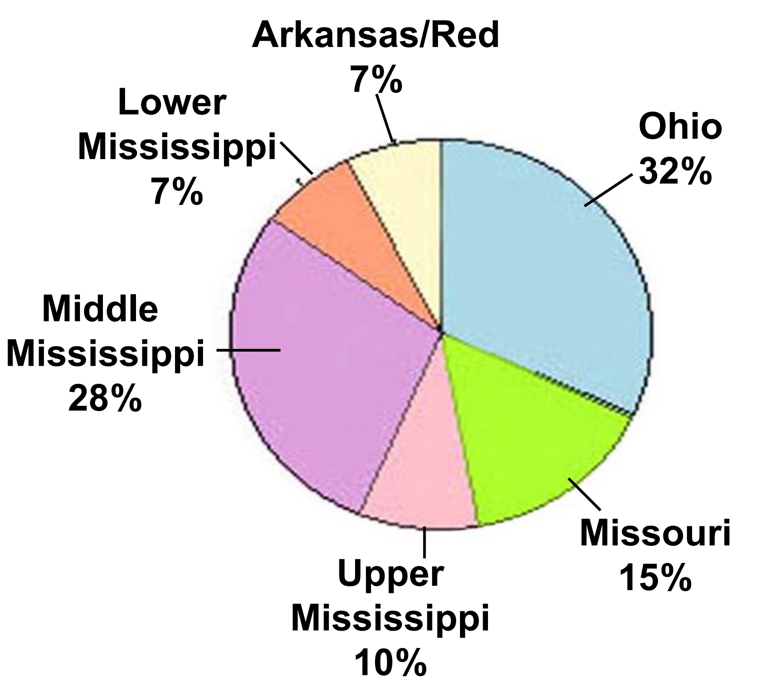
May 1999

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service
Coastal Ocean Program

Nitrogen Loads, 1980-96



1.6M metric tons per year

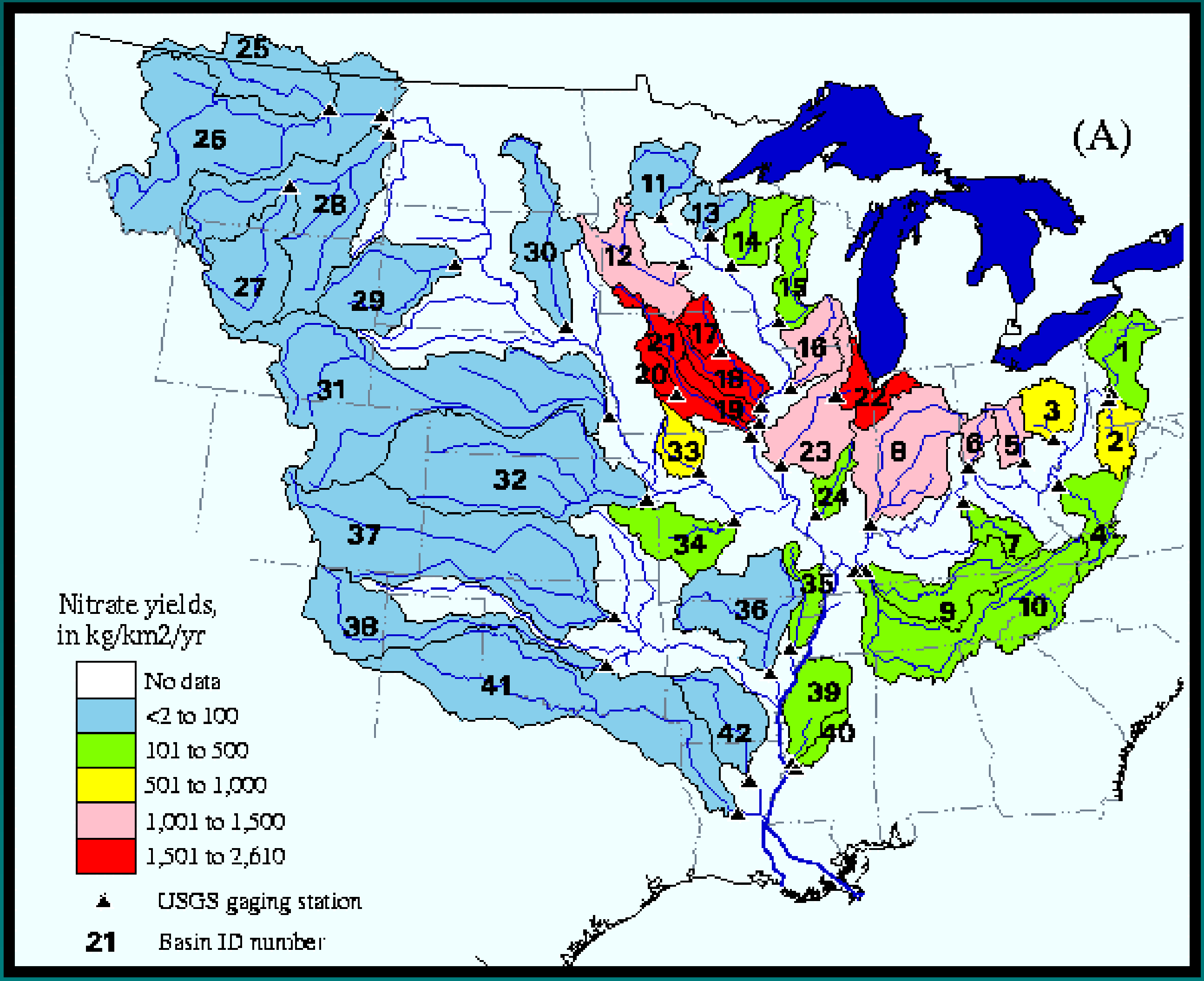


1500 Water-Quality Measurements on 9 large sub-basins.

USGS

Nitrogen Yield, 1980-96

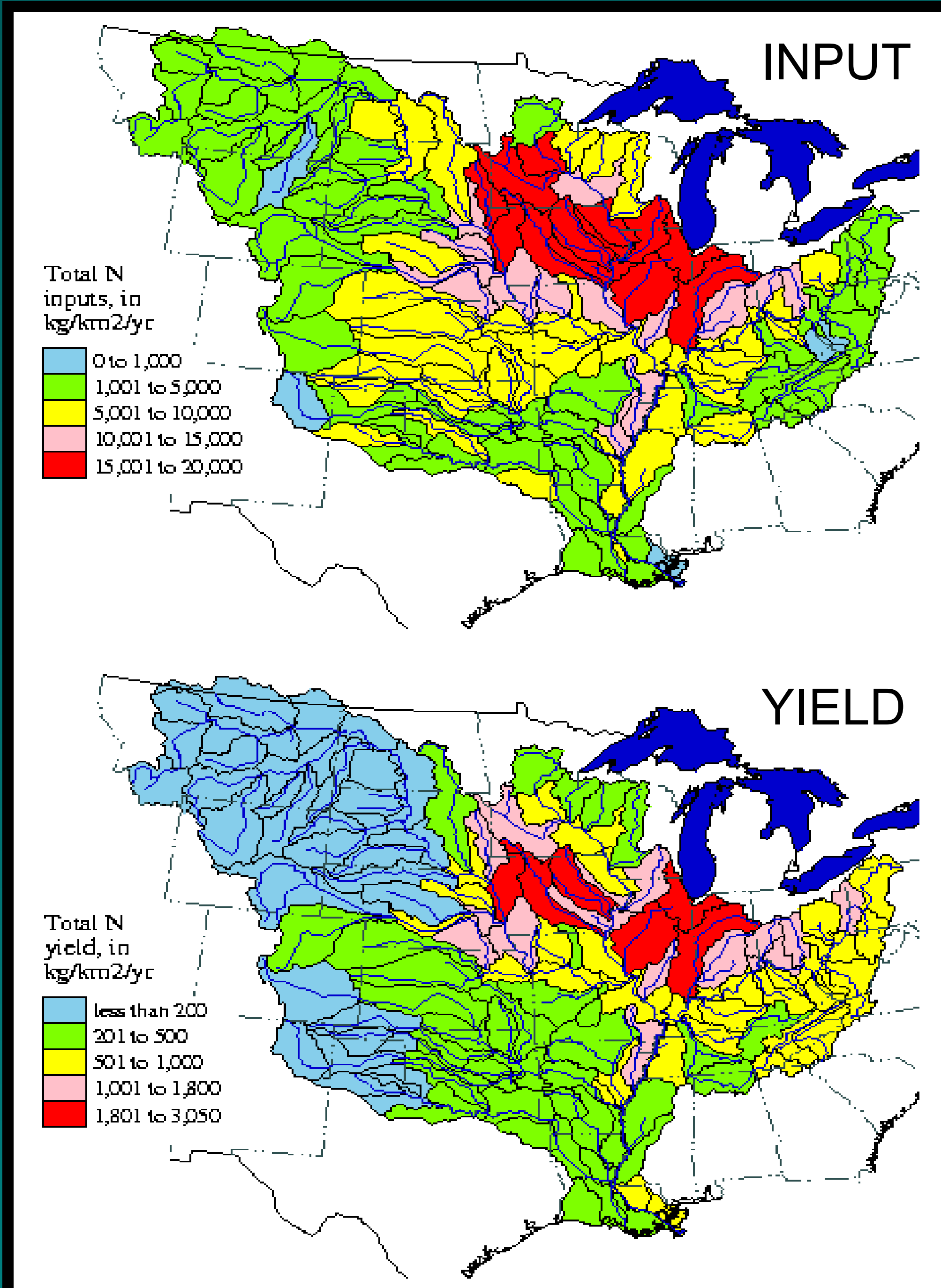
Yield on 42 small Sub-basins calculated from >4000 additional water-quality measurements.



USGS

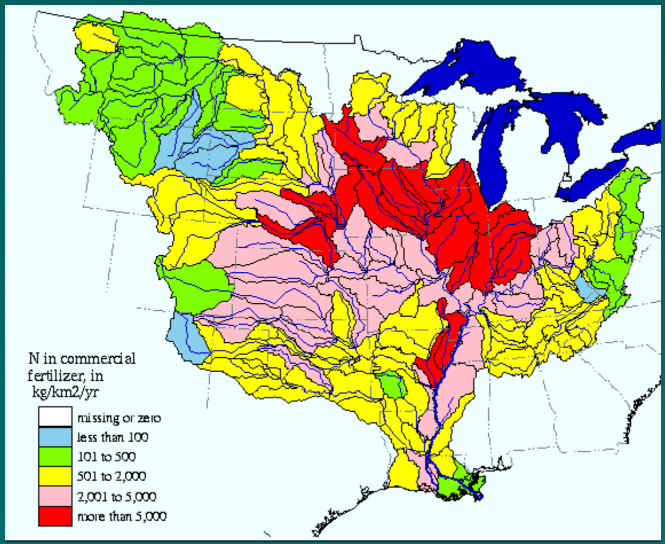
Extrapolated Nitrogen Yield, 1980-96

Statistical extrapolation from representative basins (from 42 measured Sub-basins to 133 Sub-basins of entire Mississippi Basin).

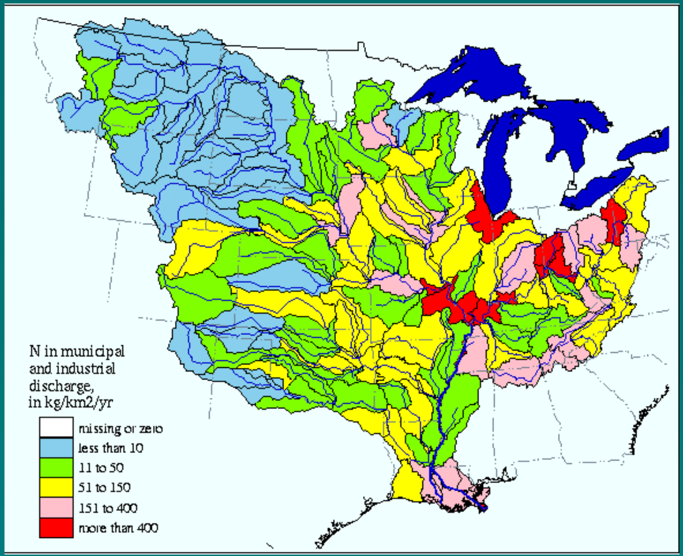


USGS

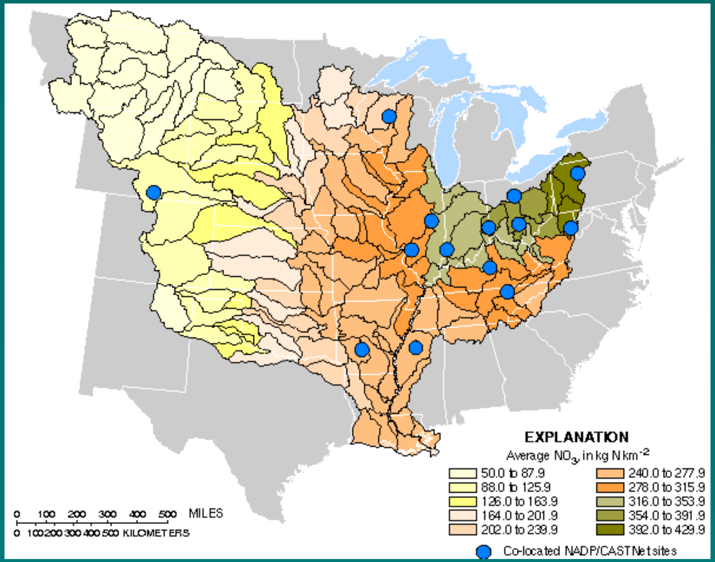
Component Nitrogen Inputs



N Input From Fertilizer



N Input From Point Sources

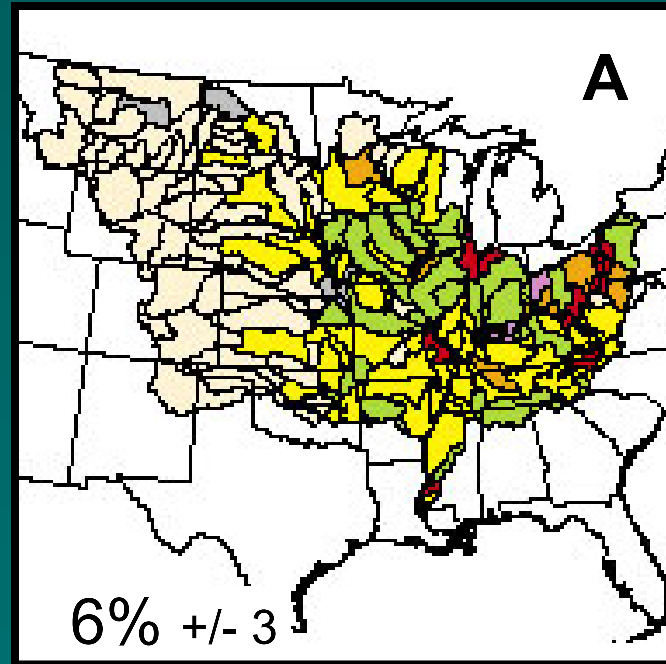


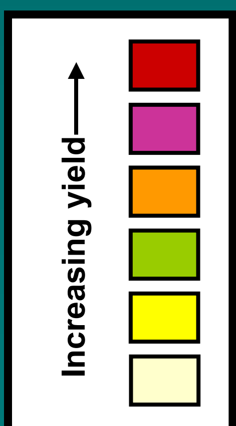
N Input From Wet Deposition

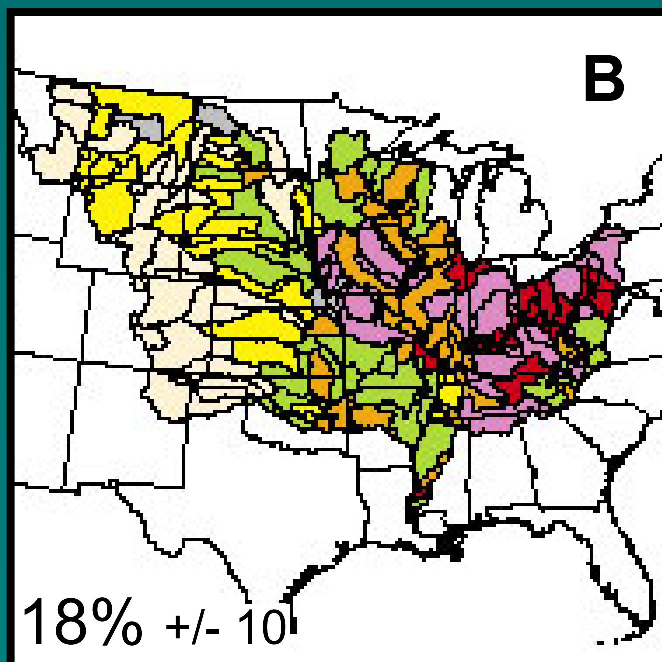
USGS

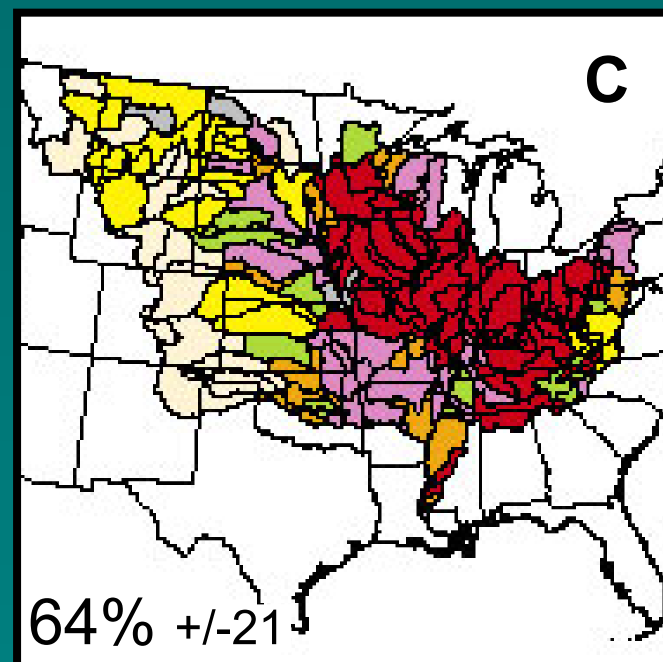
Model Estimation of Total Nitrogen Delivered to the Gulf of Mexico (SPARROW)

A - Municipal and Industrial Discharges
B - Atmospheric Deposition , and
C - Fertilizer and Livestock Wastes.





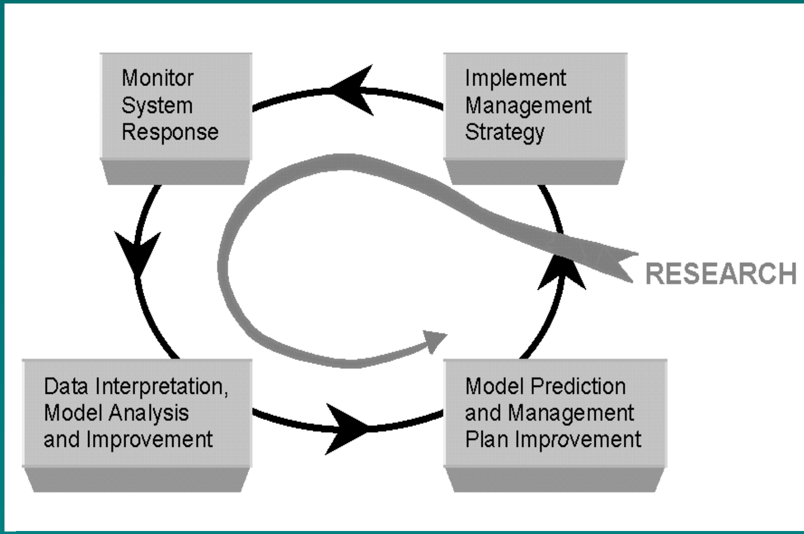


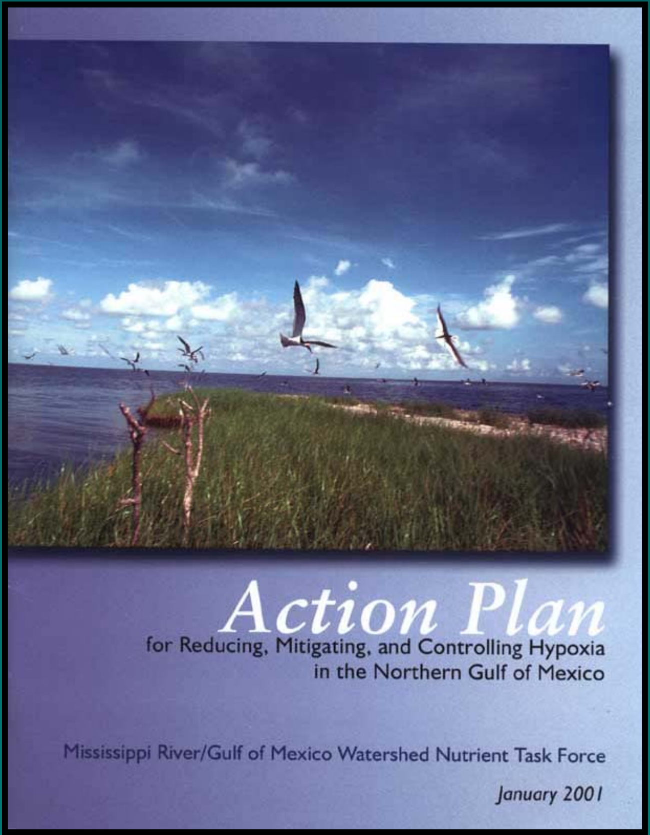


USGS

A Science-based Action Plan

- ***Adaptive management*.**
- Consider all causal and mitigating factors.
- Voluntary Basis.



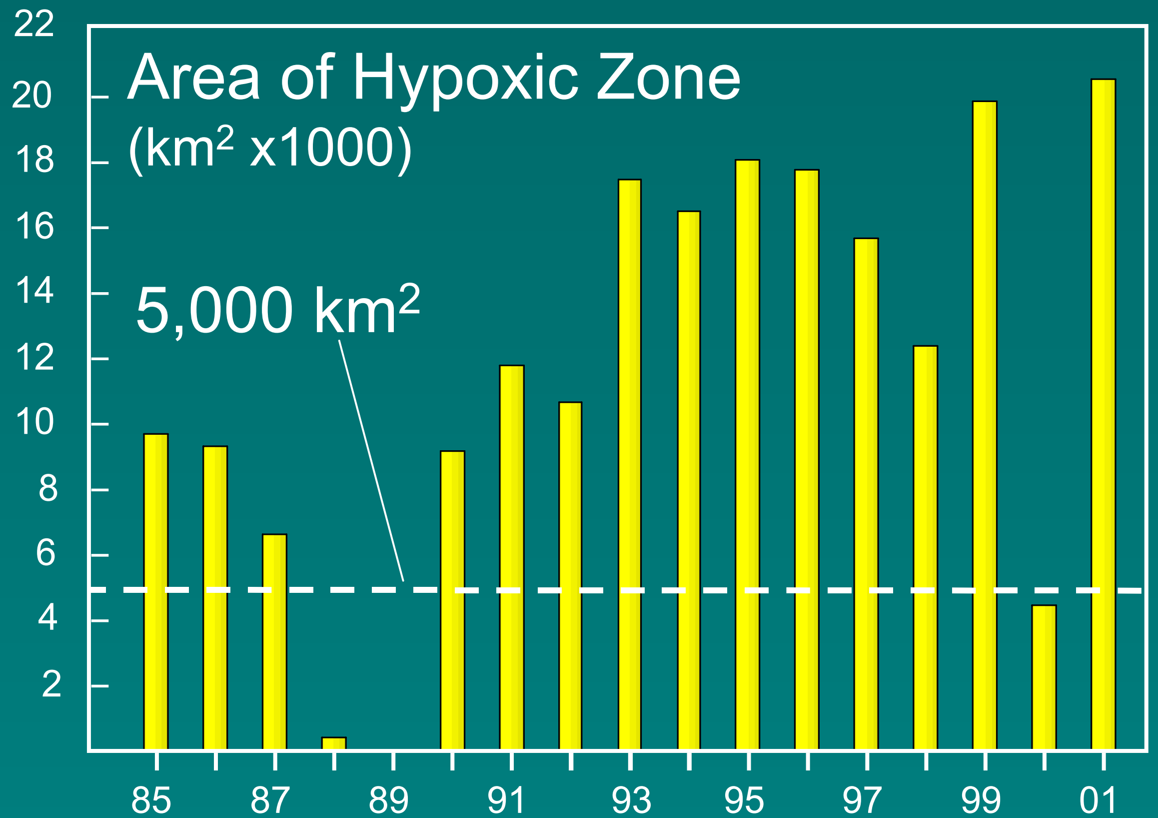


Task Force Action Plan, January 2001

USGS

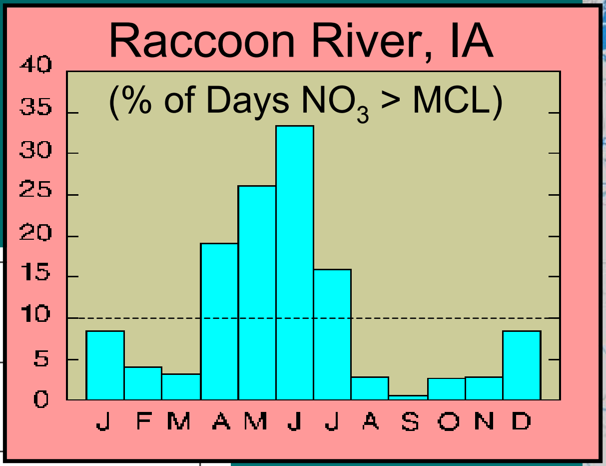
Goals for the Gulf and the Basin

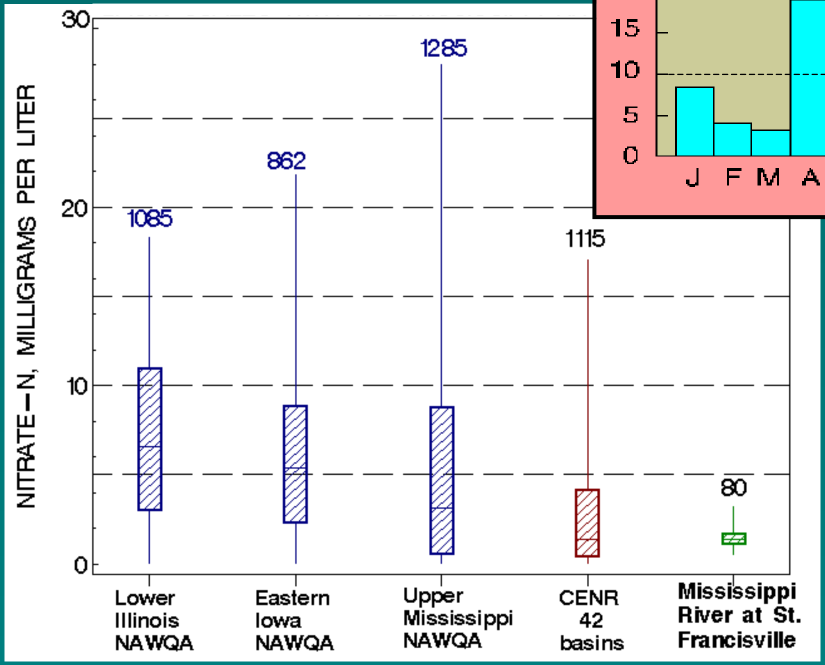
- *<u>Coastal Goal:</u> By 2015, reduce the (5-yr) average size of the hypoxic zone to < 5,000 km²*.

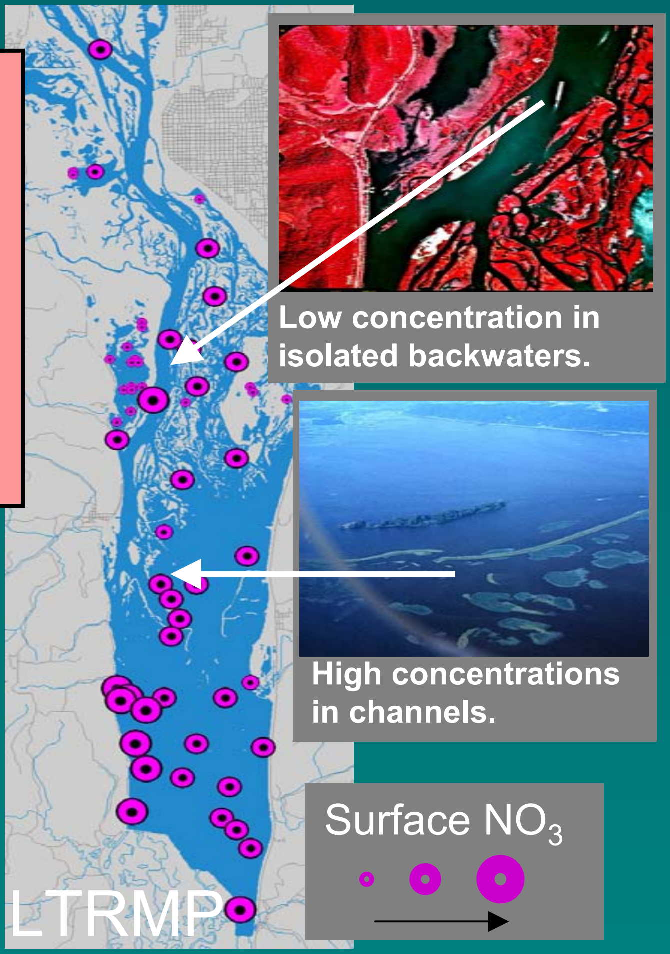


Goals for the Gulf and the Basin

- *<u>Basin Goal:</u> To restore and protect the waters of the 31 States and 77 Tribes in MARB.*

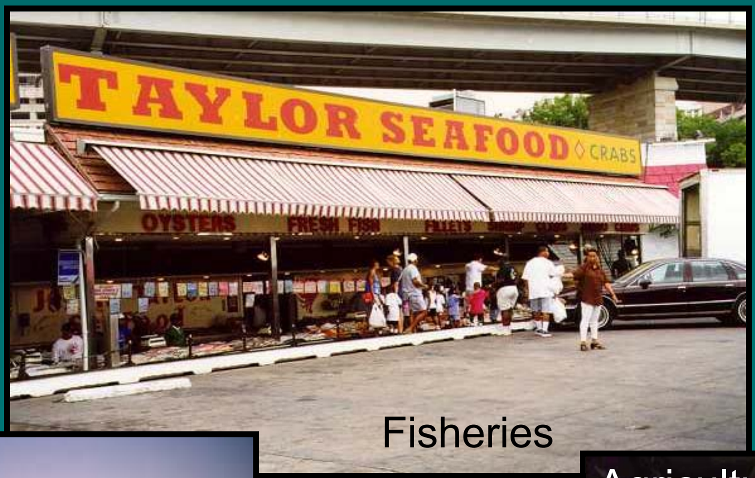






Goals for the Gulf and the Basin

- *<u>Quality of Life Goal</u>: Improve the communities and economic conditions across the Gulf and Mississippi Basin.*



Fisheries


Habitat


Recreation


Agricultural Productivity

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Reducing Nutrient Loads


Farm N Management


Riparian Forest Buffers

Decreasing N losses


Filter Strips


Fertilizer Management

USGS

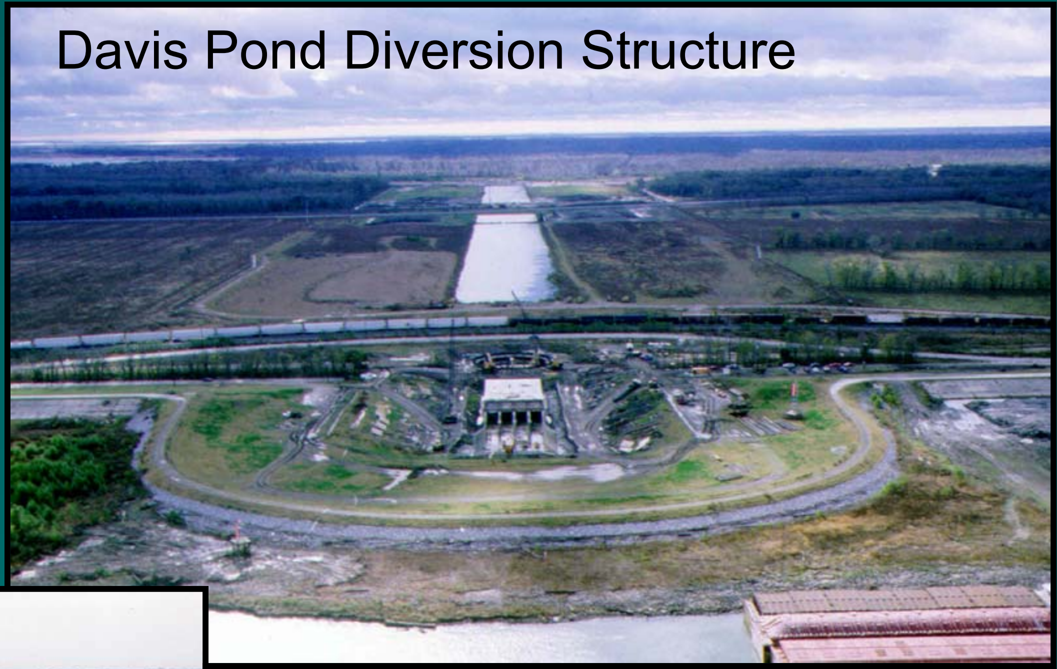
Reducing Nutrient Loads

Reducing
Point Sources
and Urban Runoff

Restoring Wetlands
to Increase
Denitrification

USGS

Reducing Nutrient Loads



Diversions to Coastal Wetlands

Increasing Denitification

Lock & Dam Management

USGS

Task Force

Organization and Progress

- Coordinating Committee (Implementation)
  - Finance/Budget Workgroup
  - Monitoring, Modeling and Research Workgroup
  - Management Response Workgroup
    - Point Sources
    - Non Point Sources
    - Restoration

Acknowledgement

- Agencies participating in the Mississippi River/Gulf of Mexico Watershed Nutrients Task Force.
- The many scientists involved in the Science Assessment.
- The many scientists who contributed to this information.

For Info on USGS and other activities related to Gulf of Mexico Hypoxia

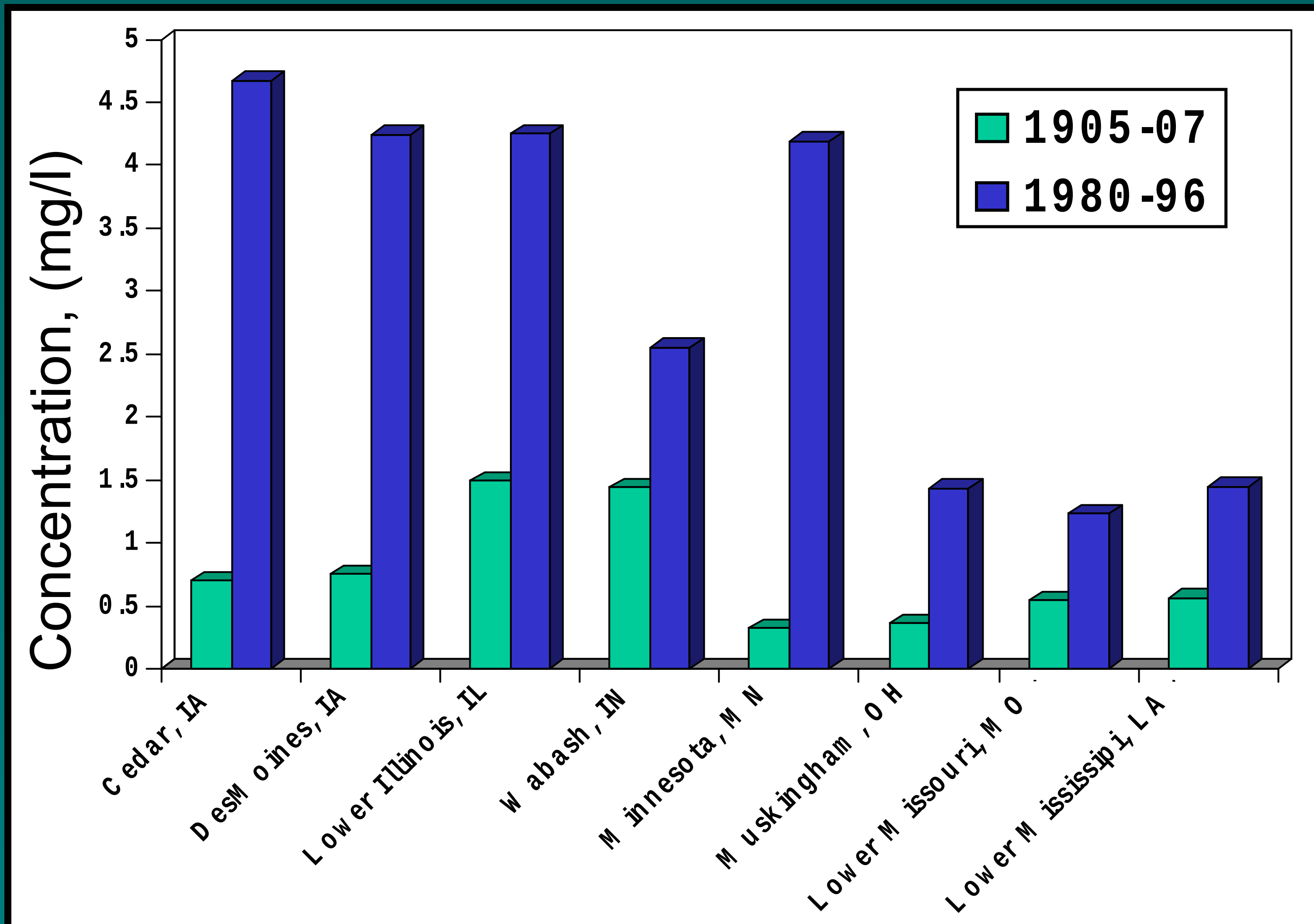
http://toxics.usgs.gov/
Click on Investigations

USGS

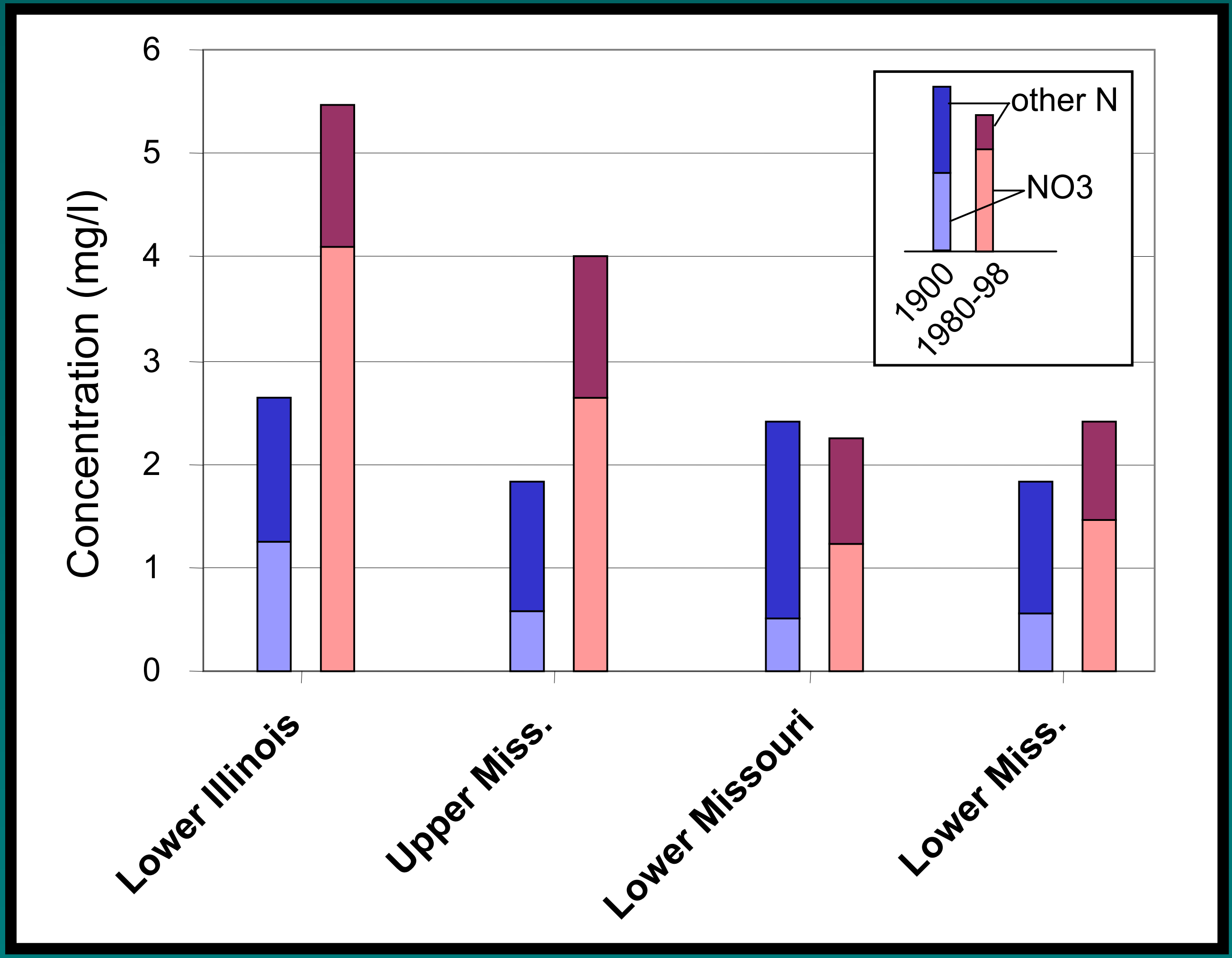
NASQAN ANALYTES

- Nutrients: - Total and Dissolved N and P
- Major Ions: - Calcium, Sulfate, Chloride
- Carbon: - Dissolved and suspended Organic C,
  - Dissolved Inorganic C
- Pesticides: - Common soluble pesticides
- Suspended and Dissolved Trace Elements:
  - Lead, Cadmium, Copper, Zinc
- Suspended Sediment:

Mean Nitrate Concentrations: Beginning versus End of 20th Century



Mean Nitrogen Concentrations: Beginning versus End of 20th Century



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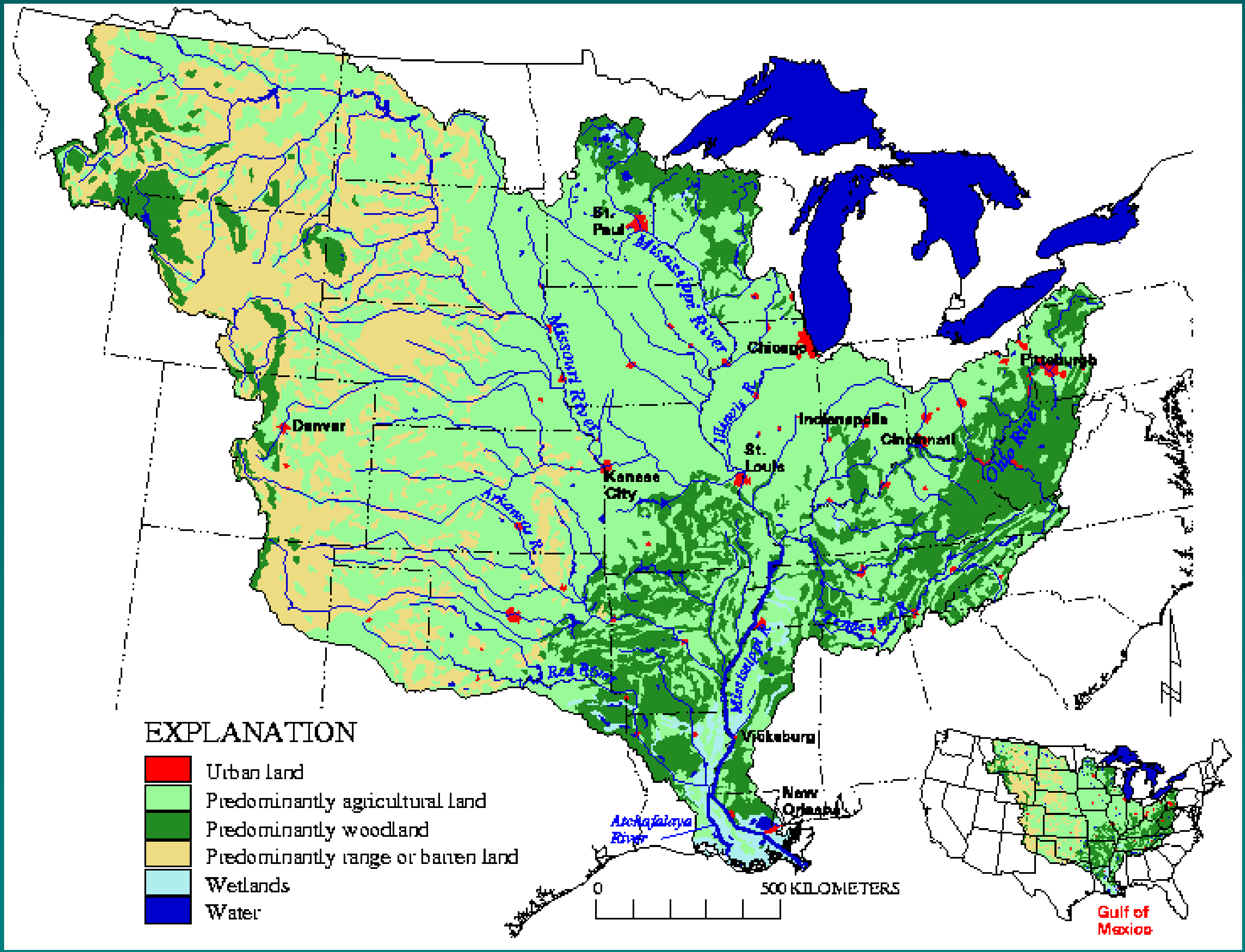
Land use in the Mississippi River



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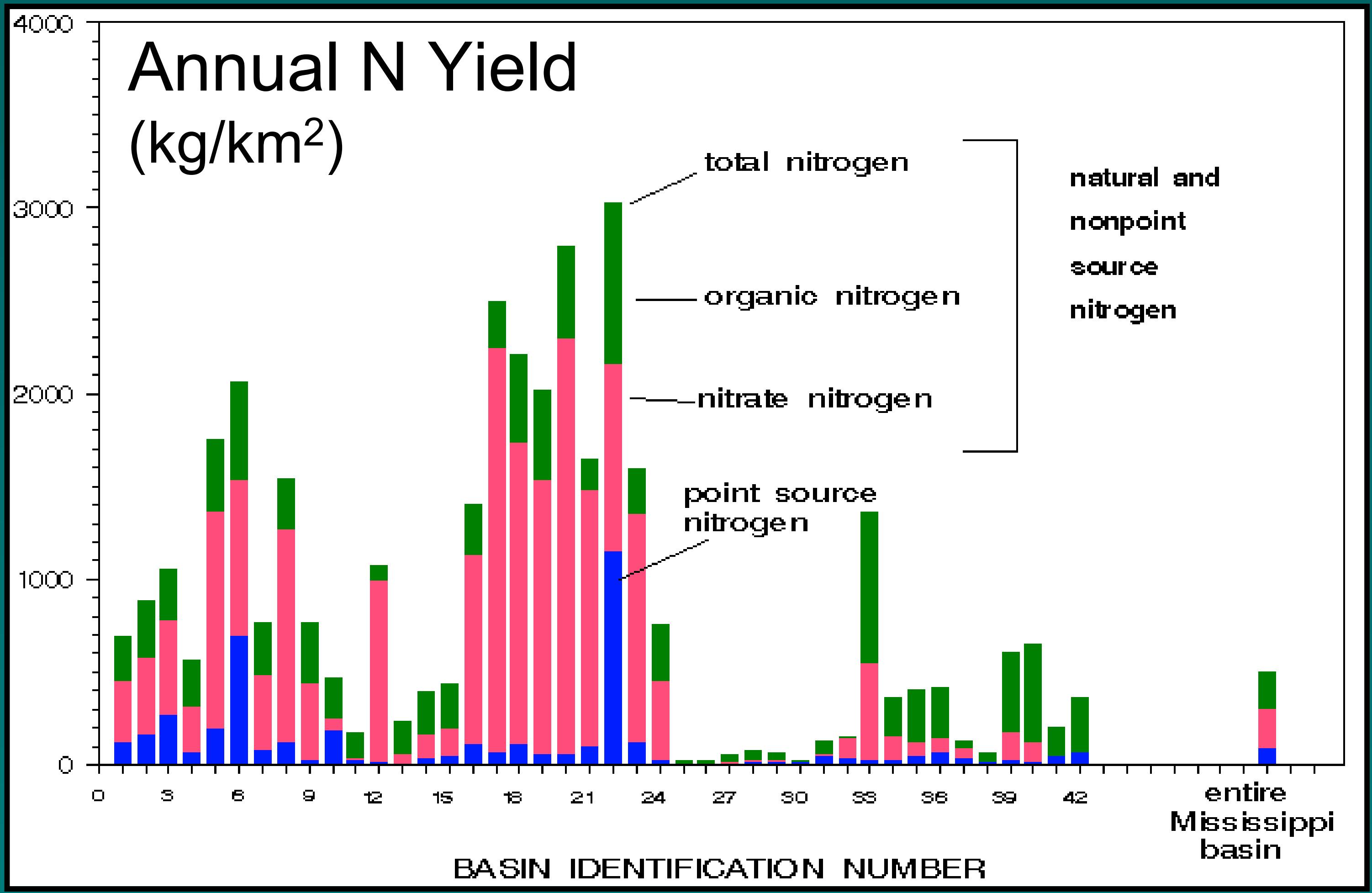
Natural, Point Source, and Nonpoint Source N



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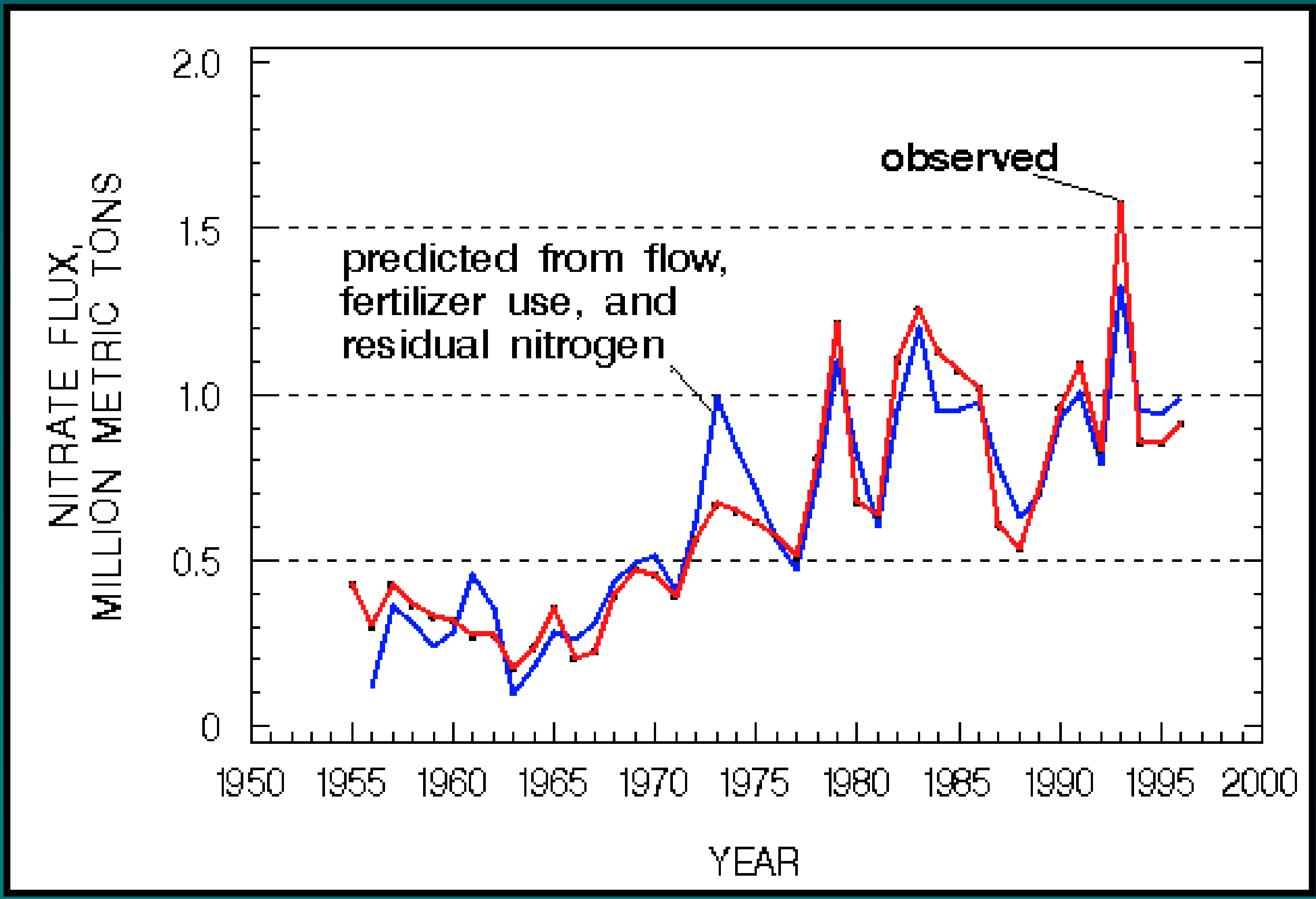
ANNUAL NITRATE FLUX – OBSERVED AND PREDICED FROM REGRESSION MODEL



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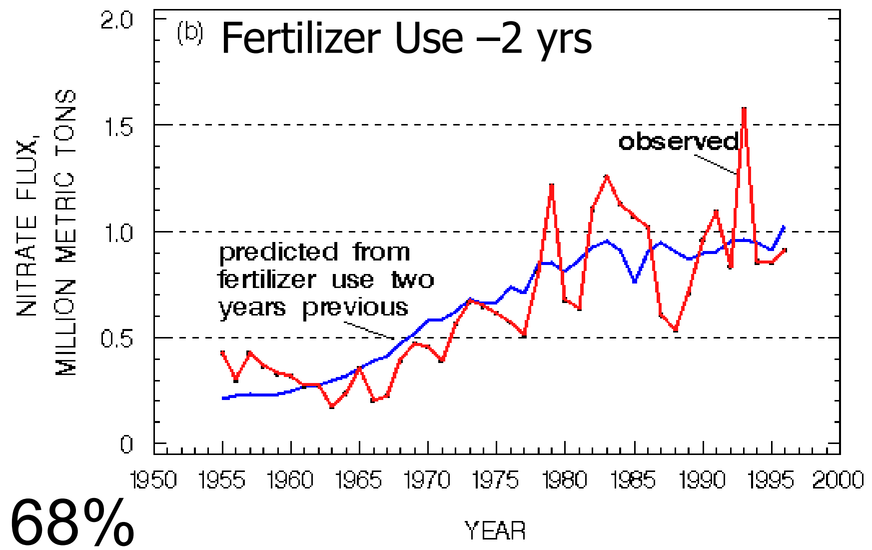
ANNUAL NITRATE FLUX PREDICTED FROM:



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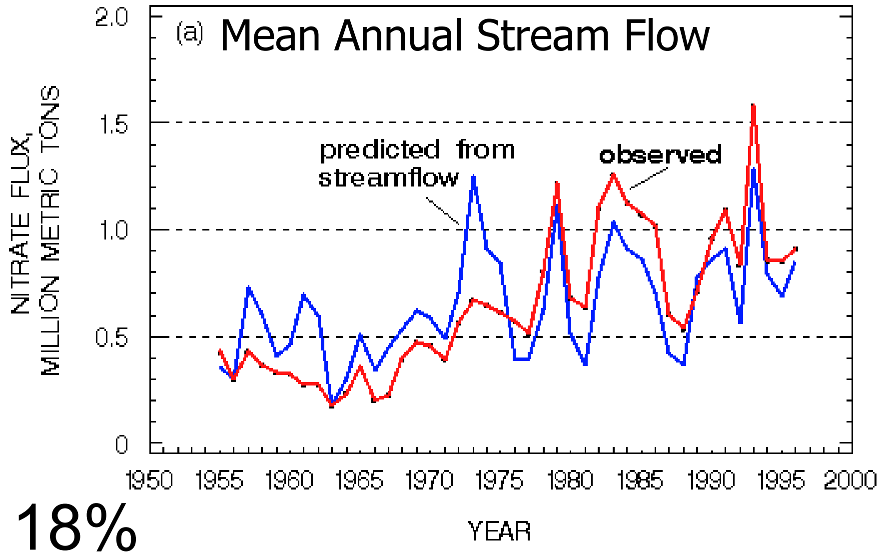
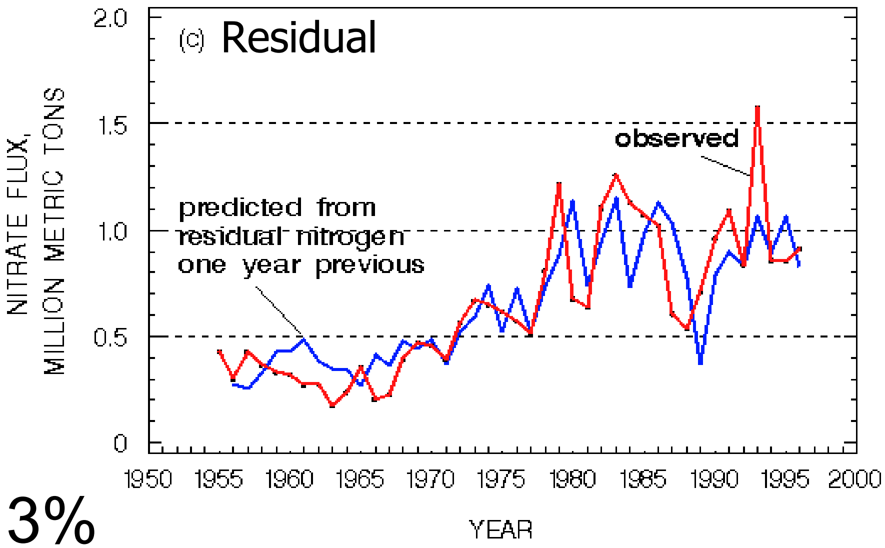


18%



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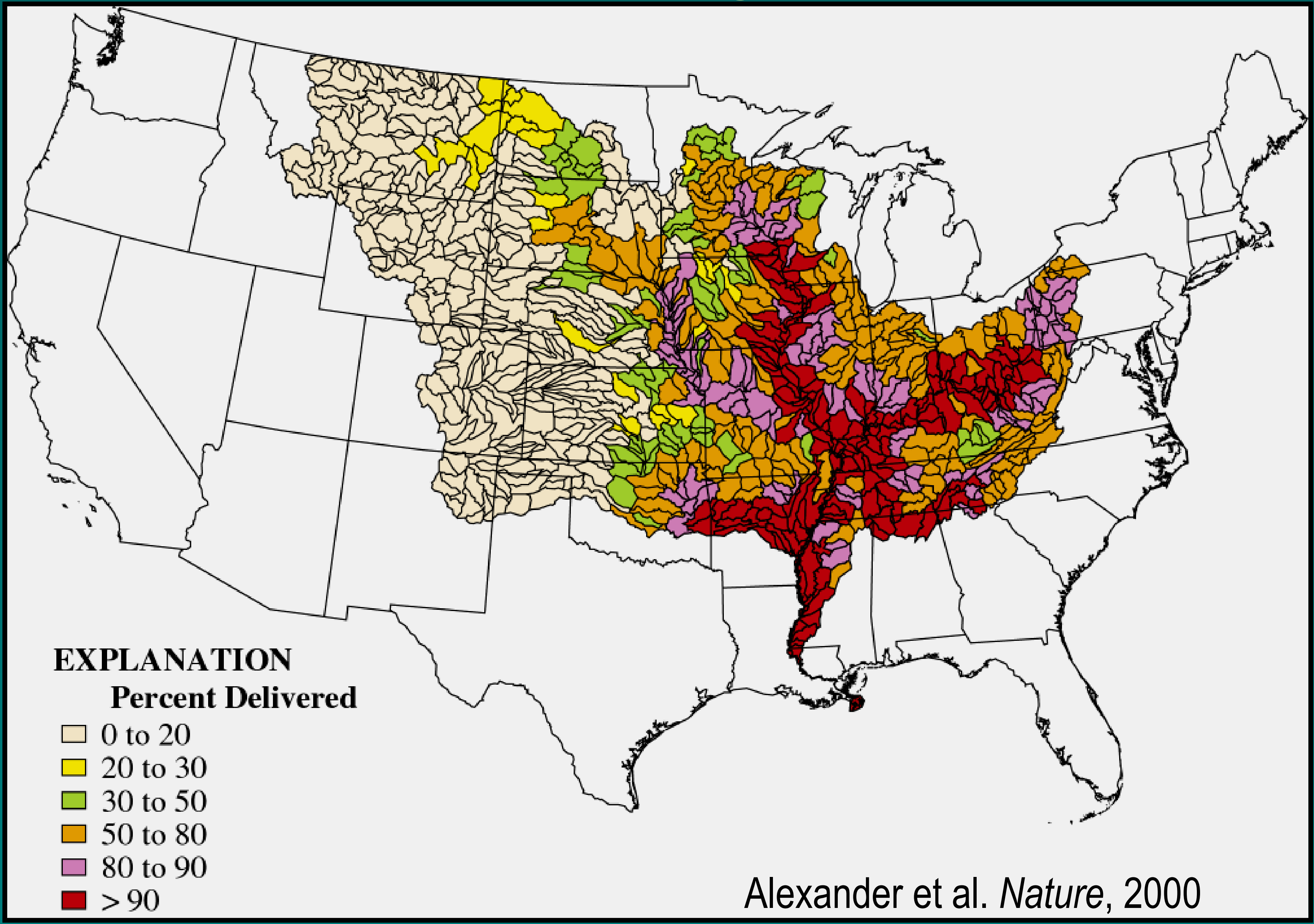
- *Within Basin Goal: To restore and protect the waters of the 31 States and 77 Tribes in the Basin.*
- *Quality of Life Goal: Improve the communities and economic conditions across the Mississippi Basin.*

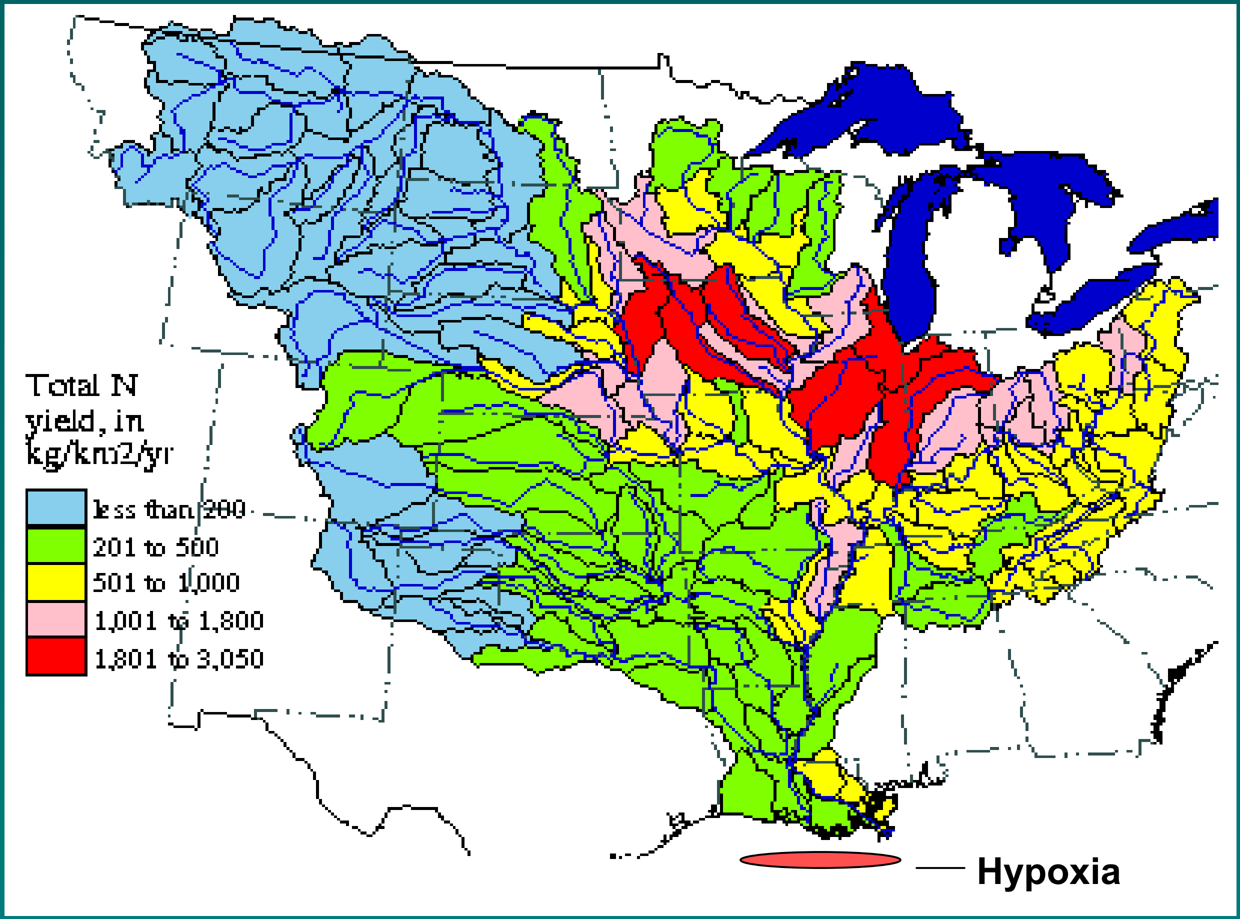
Fraction of In-Stream Nitrogen Delivered to Gulf



Alexander et al. *Nature*, 2000

USGS

The Importance of Watershed Processes



- Agric. / Urban Runoff
- Tile Drainage
- GW Storage/Discharge
- Wetland denitrification
- Riparian zone filtering
- Atmospheric Dep.
- Climatic effects

Nitrate Yields, Miss. Watershed

USGS